Departments of Chemistry and Earth Sciences

REVELLE COLLEGE

University of California, San Diego

To the National Aeronautics and Space Administration

FIFTH SEMI-ANNUAL REPORT ON RESEARCH CARRIED OUT UNDER NASA GRANT NO. NsG-319

For the period

September 16, 1964 to March 15, 1965

The period covered by this report has witnessed the completion of many of the experimental programs discussed in previous reports of this series. We are now in the stage of writing up many of our observations in publishable form. Progress reports, dealing with individual experimental programs, are given below.

I. MEA (Multi-Element Analyses)

The computer program which has been the prime responsibility of Mr. Richard Cox (termed the "MEGA" program) is now completed. We are modifying it for use with the instrumental activation analyses discussed below. It is clear that MEGA shall save us many man-hours in reducing the data for these as well as new experimental programs.

Mrs. Virginia Frankum has returned to our group (part-time employment) and is responsible for most of the chemical separations in the MEA work. MEA-6 is about half-completed, in terms of the chemical operations, and counting of Ag, Pd and Te samples is under way. We have experienced some unforeseen difficulties with the chemistry and it is possible that additional work should be done to improve chemical yields and separations for the overall procedure.

We have begun to review data from MEA 1 through 5, using the MEGA program, and shall continue this work during the next six months. In summary, the MEA project is progressing satisfactorily, especially in view of our heavy commitment of time, laboratory space and counting facilities to other work, notably the instrumental analyses discussed below.

II. Outgrowths of the MEA Project

Dr. L. Paul Greenland has submitted a paper on "Gallium in Chondritic Meteorites" to J. Geophys. Res. (copies of the preprint of this paper have been forwarded to NASA). Dr. Greenland and I are submitting a paper on Cu and Zn abundances to Geochim. et Cosmochim. Acta (copies enclosed). A notable feature of this work is the comparison of Cu abundances via three different activation analysis techniques: single-gamma spectrometry, gamma-gamma coincidence spectrometry (both being instrumental techniques) and "classical" activation analysis, with addition of carriers, dissolution of samples, etc. This sequence of techniques has been applied to six meteorite samples, with results in excellent agreement with each other. The gamma-gamma coincidence method for Cu^{64} was first applied during the period covered by this report, and has proven to be a superior technique for determining Cu. Experimental work on abundances of the halogens and the chalcophilic elements mentioned in the previous semi-annual report is completed and papers presenting these data and our interpretations of them are in preparation.

III. Instrumental Activation Analyses

The paper on "Abundances of Na, Sc, Cr, Mn, Fe, Co and Cu in 218 Individual Meteoritic Chondrules....," preprints of which accompanied the previous report, is scheduled for publication in the May 15th issue of J. Geophys. Res. Our paper on abundances via INAA (instrumental [thermal] neutron activation analysis) is still in preparation, since we have been compelled to revise it extensively as a result of further data on carbonaceous chondrites (see "Quarterly Progress Report, NASA Research Contract NASw-843, period ending November 30, 1964: GA-5900," by R. A. Schmitt for details of these observations).

Analyses of mineral separates and fragments have led to results which in some respects are self-inconsistent (although in other respects, e.g., the abundances of Na in olivines, the data are both remarkably consistent among themselves and in good agreement with INAA work on terrestrial rocks). In at least one case, this is due to incomplete mineral separations (no heavy liquids were used in this work). It is clear both that much of the future research effort must be directed toward analyses of mineral phases and that more time must be spent on developing methods of obtaining high-purity mineral separates without undue risk of contamination. Our past collaboration with Dr. Brian Mason, in which he has supplied us with mineral separates from a number of meteorites, perhaps points to a resolution of these problems. I intend to try a series of experiments with a Frantz separator (available through the courtesy of Prof. A. E. J. Engel of this University) on relatively fine-grained materials from chondrites. It seems possible that, with careful control of the separation parameters and by approaching the true grain size of the (typically) highly intergrown meteoritic minerals, cleaner separations might be achieved without resorting to heavy liquids.

The analyses of ultramafic rocks via INAA, which were discussed in the previous report, are completed. Mr. Alan Stueber is writing up this material as part of his Ph.D. thesis. We shall begin preparation of the data for journal publication sometime in late summer or early autumn.

IV. Other Work

I have prepared for publication a review entitled "The Origin and Evolution of the Planets." Copies are enclosed.

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